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INFORMATION SEARCH AND THE EFFECTS OF FAILURE:

A TEST OF COMPLEXITY THEORY

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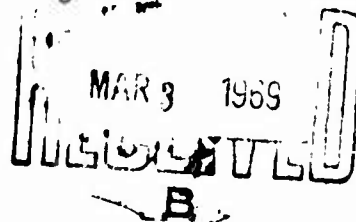Technical Report No. 18

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Abstract

The effects of increasing failure and of individual differences in the complexity of conceptual structure on dyad decision-making teams were examined. A complex experimental simulation environment was used as the research method. It was found that simple subjects engaged in more delegated information search than complex subjects, probably due to the influence of social desirability. No differences between simple and complex groups of subjects were found in self-initiated information search. This form of search increased with initial increasing (lower) failure levels, and remained fairly constant under higher failure levels. Two measures of integrative information utilization were employed. The number of information search moves later utilized in integrative (strategic) decision making produced an inverted U-shaped curve with optimal levels under moderate failure conditions. Efficiency of information utilization showed a general decrease as failure increased. Complex groups of subjects exceeded simple groups on both measures of information utilization. The data produced only limited support for complexity theory, and did support, where applicable, the information search theory of Feather.

INFORMATION SEARCH AND THE EFFECTS OF FAILURE:
A TEST OF COMPLEXITY THEORY[1]

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General Introduction

For many years, psychologists have been concerned with attitudes, with
decision making, and with a host of other behavioral characteristics of in-
dividuals, groups, and organizations. Often, however, the bases of these
decisions, attitudes, etc., have been ignored. Decisions, for instance,
are in part based on the inherent or developed characteristics of the de-
cision-making system. In another part, however, they are based on the in-
formation available to that system (whether individual, group, organiza-
tion, etc.) at the time, or immediately preceding the time, when the decision
is made. In the work with which we are concerned here, the emphasis in on
both: the gathering of information, both through delegated search and self-
initiated search, and on the use of this information in the decision-making
process itself. When we speak about delegated search, we are considering
a search activity which in the military might imply giving orders to gain
information. When we consider self-initiated search, we are concerned with
information search activity which requires the searching person or group
to engage in activity that provides information which may be used for fur-
ther activity. Both may produce the same end result: information; however,
as past research has shown, they do not show similar characteristics.

Theory and Research on Information Gathering

In recent years, psychologists have demonstrated considerable interest
in the search for, and the use of, information by human decision makers.
Approaches to the problem, although at times convergent in conceptualization
of "information search" and its implications, have been quite divergent in
research methodology and theoretical basis. Brock (in press) sees infor-
mation value, and with it search, as an inverse proportion of information

availability. Lanzetta and associates (e.g., Driscoll and Lanzetta, 1965; Driscoll, Lanzetta, and McMichael, 1967; Hawkins and Lanzetta, 1965; Sieber and Lanzetta, 1964) have related information search to the "uncertainty" concept. They found that uncertainty produces information search or preference for information until low (1 bit) levels of uncertainty remain, that higher levels of uncertainty produce faster and more search, and that importance suppresses (or has curvilinear relationships to) search. Other researchers have related information search to models of consistency (e.g., Festinger, 1964; Rhine, 1967), suggesting that search is produced by confidence in the searching person that he can deal with potentially dissonant information, and that the information obtained is "useful" to that person. (However, research support for this view has been only partial, cf. Canon, 1964; Freedman, 1965). Messick (1965) has used computer simulations to predict sequential information seeking.

Other work has related information search to risk taking (Edwards, 1965; Edwards and Slovic, 1965), to personality variables (Driver and Streufert, 1966; Haaland, 1968; Long and Ziller, 1965) and other concepts (e.g., Marsh, 1967; Paisley, 1966; Pitz, 1968). Few theoretical or experimental approaches, however, have considered the effects of both situational and personality variables on information search, as is suggested by Cronbach (1957), Eysenck (1966), Feather (1962b), and MacKinnon (1944). Exceptions are the work of Feather (1967) with a model employing motive, expectancy, and incentive, and the work with complexity theory of Driver and Streufert (1966), Schroder, Driver, and Streufert (1967), and Streufert and Driver (1967). The latter model has been extended or related to other research concepts by Sieber and Lanzetta (1964) and Streufert, Suedfeld, and Driver (1965). The latter approach to information search is continued in this paper. We are primarily concerned with a further test of complexity theory as it predicts information search and information utilization. However, other approaches, e.g., those by Lanzetta and associates, by Feather, and by Brock will also be considered. The present research method employs the Tactical and Negotiations Game (Streufert, Kliger, Castore, and Driver, 1967; Streufert, Kliger, and Castore, 1967), a complex experimental simulation which has been previously shown to be very useful for analyses of information search and

information utilization (cf. Stager, 1967; Streufert and Driver, 1965, 1967; Streufert and Schroder, 1965; Streufert, Suedfeld, and Driver, 1965; Suedfeld and Streufert, 1966).

Complexity and Information Search

Complexity theory, as formulated by Driver and Streufert (1966), Schroder, Driver, and Streufert (1967) and Streufert and Driver (1967), is concerned with the effects of two kinds of complexity on behavior: (1) the complexity of the environment in which behavior occurs, and (2) individual differences in the complexity of a decision maker's conceptual structure. Driver and Streufert (1966), Schroder et al. (1967), and Streufert and Driver (1967) consider "environmental complexity" to consist of at least three components which "add in some fashion" to produce a total value of "environmental complexity": (1) information load, or the quantity of information received by the subject(s) per unit time, (2) noxity, or the proportion of failure content of that information, and (3) eucity, or the proportion of success content of the information.

Individual differences in the complexity of subjects' conceptual structure are viewed as varying from simple (subjects who neither differentiate nor integrate) via several intermediate points (where first differentiation and then integration occurs in increasing degrees) to complex (for subjects who display differentiation and high levels of integration).[2]

Schroder et al. (1967) have suggested that individual performance differences in differentiation and integration should in part be based on different orientations of subjects toward information. The theory holds that (in general) complex persons should search for more information than simple persons. This should be particularly true when the information sought (and obtained) may be incongruent with existing attitudes, may not be immediately relevant to immediate behavioral requirements, or may have more remote implications. According to an extension of complexity theory with regard to information search (Streufert, Suedfeld, and Driver, 1965), simple subjects may search for more information when the information can be used for one-to-one responding, and when search does not involve them in active contact with potential incongruent or remote cognitions. Streufert

et al. (1965) also propose that increasing environmental complexity should produce decreasing information search. This decrease, however, should be more pronounced for simple subjects than for complex subjects, since simple subjects should be less selective in responding to information in the environment, and would consequently spend more of their time in "retaliatory" or "respondent" (cf. Streufert, Driver, and Haun, 1966; Streufert, in press) interaction with their environment, leaving them with less time to search for information. Complex subjects, on the other hand, should filter out information they would consider irrelevant to their present intent, leaving them with more time to search for information. This view does not necessarily postulate higher information search by complex subjects under low environmental complexity levels. Finally, both versions of complexity theory predict that integrative (strategic) information utilization should be higher for complex persons than for simple persons, and that optimal information utilization should occur at intermediate levels of environmental complexity.

Previous research has tended to support some of the postulates of Schroder et al. Tuckman (1966) has shown that complex subjects engage in more interpersonal probing than simple subjects. Karlins and Lamm (1967) and Karlins (1967) found that complex subjects search for more information when exposed to a novel environment. Stager (1967) found that information search is a linear function of the proportion of complex subjects in decision-making groups. Similar results have been obtained by Long and Ziller (1965) with information search and the somewhat related concept of dogmatism. These experiments, however, have studied general information search characteristics of simple and complex subjects, using task situations where the subjects were engaging in active information search in more or less constant environments, where the information obtained was at least in part remote from immediate needs of the subjects. A more extensive analysis of information search by Sieber and Lanzetta (1964) and by Suedfeld and Streufert (1966) and of information search and information utilization by Streufert, Suedfeld, and Driver (1965) produced data of somewhat greater complexity. The latter researchers measured both active (self-initiated) and delegated information search, as well as utilization of the information gained through search. Their data were collected under conditions of varying information

load (the "quantity of information received by subjects per unit time" com-
ponent of environmental complexity). They found that generally information
search decreases as information load increases from 2 to 25 items of infor-
mation per one-half hour, and that subjects scoring high on measures of com-
plexity of conceptual structure are less affected by changes in information
load than are their lower scoring counterparts. Generally simple subjects
engaged in more delegated information search. Complex subjects, however,
engaged in more self-initiated information search under high levels of
information load.[3] Streufert et al. (1965) also found that groups of com-
plex subjects utilize the information obtained through search moves in a
more integrative fashion than simple subjects. This finding held particu-
larly under optimal (moderate) information load conditions (for analyses of
information optimality see Streufert and Schroder, 1965; Streufert and
Driver, 1965, 1967; Streufert, Driver, and Haun, 1966; and Streufert, in
press). These fi.. .ngs would lend support for the view of Streufert et al.
(1965).

The research discussed above has been only concerned with the informa-
tion load component of environmental complexity. Research on the effects
of the failure (noxity) and success (eucity) components of environmental
complexity and their relationship to information search has not been repor-
ted so far. In this paper, we are examining the effects of failure (the pro-
portion of a constant quantity of information communicating failure) infor-
mation on various measures of information search and information utilization.
This paper, then, extends the test of complexity theory to predictions with
reference to the second of the three "components" of environmental complex-
ity. Data obtained should (1) follow theoretical predictions, and (2)
produce "parallel effects" to data obtained under load variation, if com-
plexity theory is to be supported.

Method

Subjects

Five hundred and seventy-six paid male volunteers were tested with the
Sentence Completion Test (Schroder and Streufert, 1963; Schroder, Driver,
and Streufert, 1967) as a measure of conceptual structure. The tests were

scored on a seven-point scale. Scores 1 and 2 represent simple structure: no differentiation, no integration. Scores 3 and 4 represent levels of differentiation, but no integration. Scores 5 and 6 represent complex structure with differentiation and integration, and score 7 represents highly complex structure with differentiation and high levels of integration. Interrater reliability on scoring the test was r = +.92. Split half reliability was r = +.83. Total test scores were based on the results from the two most complex (differentiated or integrated) responses obtained from each subject.

Twenty-four subjects of simple conceptual structure (score 1, no differentiation, no integration) and twenty-four subjects of complex conceptual structure (scores 5 through 7, capacity to differentiate and integrate) were selected for participation in the experiment. Structurally homogeneous two-man groups (dyads) were formed. Subjects participated in the experiment for a period of ten consecutive hours. They were paid one dollar for each hour, and were promised an extra four dollars if they would "win" the game. However, the progress and outcome of the game (unknown to the subjects) was predetermined (see below).

The Environment

Each of the twenty-four dyad decision-making teams was given the task of directing the military, economic, intelligence, and negotiation activities of a small underdeveloped nation called "Shamba," which was plagued by an internal revolution.[4] Subjects read a manual on historical, economic, and military information about this nation. The time required for reading the manual was approximately two hours.[5] After reading the manual, subjects were told that they would be permitted to make decisions of military, economic, intelligence and negotiation characteristics within the limits of their resources. Decisions were made on forms provided for this purpose and handed to the experimenters. Subjects were informed that they were playing the Tactical and Negotiation Game against another team, and that the game would continue for a number of periods of indeterminate length until the issues of the "Shamba conflict" were resolved. The experimenters would serve as judges, assisted by a computer, and information on the outcome of subjects' decisions would be fed back to them as soon as available.

In fact, subjects were playing against a pre-determined program. Subjects received seven pre-typed messages (all teams received all messages in different random order) equally spaced during each of six one-half hour periods. Intermissions between the periods were used to supply the subjects with food and soft drinks, and to have them fill out additional forms (rating scales). Subjects were not told which period would be their last.

Of the seven messages received by the subjects during each one-half hour period, two reported on military, two on economic, two on negotiation and one on intelligence "results." The order of the reporting areas was varied at random. During the first period of play, one message (selected at random) reported failure. All other messages were neutral in content. During the second period, two messages reported failure, and so forth, until in the last (sixth) period, six out of seven messages reported failure. In other words, failure was steadily increased across periods from level 1/7 to level 6/7.[6] In line with the results previously reported by Castore and Streufert (1966) and Higbee and Streufert (1968), failure perception (obtained on a rating scale in the intermission after each playing period) increased in linear fashion with induced failure levels.

The design of the game (cf. Streufert, Kliger, Castore, and Driver, 1967; Streufert, Castore, and Kliger, 1967) and the characteristics of the program (informative messages) assures that subjects receive information that sufficiently answers the majority of their information search decisions. Subjects' responses to a scale concerned with the quality of information feedback in response to search decisions indicated that they perceived information quality to be consistently moderately high.

Subjects' estimates of attribution of causality (cf. Streufert and Streufert, in press) were obtained during each intermission. For this purpose subjects were asked to indicate the percentage of their current situation that was caused by (1) their own decisions, (2) decisions of the opposing team, (3) chance factors, (4) arbitrary decisions of the experimenters, and (5) characteristics of the environment. The total had to sum to 100 per cent. It was found that combined causality attributions to the last three components did not rise above 20 per cent. Attributions to own decisions and decisions of the opposing team each remained near 40 per cent, and were relatively constant

across increasing failure levels (periods). These results were considered support for the face validity of the experimental manipulation.

The selection of seven (rather than a smaller or larger number) information messages per one-half hour was determined by the previous results reported by Streufert and Schroder (1965) and Streufert and Driver (1965, 1967). These researchers have shown that optimal integrative decision making is reached at an information load level of ten messages per one-half hour period (when success and failure components are absent or low). If information load and failure are additive components of environmental input (as proposed by complexity theory), then the initial rise and subsequent decline in integrative information utilization under conditions of increasing failure could only be obtained if information load levels are sub-optimal and success levels are low or absent. (No success messages were presented to the subjects in this experiment.)

Data Collection

Delegated information search. After the end of each 30-minute playing period, the subjects were given a number of tests and rating sheets to fill out. Among these was the following item:

The information you are receiving is prepared for you in the same way it would be prepared for real commanders by a staff of intelligence officers. These persons have been instructed to inform you only of important occurrences. You may feel that these men do not give you sufficient information or do not give you adequate detail. On the other hand, you may feel that the information you are receiving is too detailed and you are presented with some unimportant information. You may instruct these intelligence officers to increase or decrease the amount of information they present to you. We would like you to decide this matter for yourself. Please do not consult the other commander on this issue at any time. We will adjust the information flow according to the combined opinion in your group. Please check your preference in comparison to the immediately preceding game period:

I would prefer to:

    receive much more information

    receive a little more information

    receive about the same amount of information

    receive a little less information

    receive much less information

In the analysis, the above choices were assigned scores 5, 4, 3, 2, and 1, respectively. (In actuality, information load was predetermined and was not adjusted in accordance with requests by subjects.)

    Self-initiated information search. In contrast to the above measure, which was gained from each individual subject, this measure as well as the measures of information utilization was gained from the group as a whole. Self-initiated information search is an expression of the number of information search orders written by the teams of subjects during a particular 30-minute period.

    Information utilization frequency. Here we are concerned with the use made of the information supposedly gained through self-initiated search. A score of 1 was assigned to each future decision which was based on information received by subjects relevant to any previous information search decision (cf. Streufert and Schroder, 1965). The total score for any playing period is then the number of future decisions which are consequentially related to information search decisions made by a team during that particular period.

    Information utilization efficiency. Here we are concerned with the proportion of information search decisions which are utilized in later integrative decision making. Since the programmed information received by groups of subjects is randomized, none of the groups could have gained an advantage over others in terms of the relevance of obtained information to their search decisions. Although these scores could vary from 0 to 1.0, it is unlikely that a score of 1.0 could be reached, since randomization of programmed informative messages makes a programmed "response" to all information search decisions unlikely. (A count indicates that on the average 73% of all search decisions "resulted in" relevant "response" programmed messages for a period of time equivalent to one playing period (30 minutes real time). This value did not differ for groups of simple vs. groups of complex subjects.)

Results and Discussion

The obtained data were analyzed as four separate two-way mixed design Analysis of Variance designs. We will treat the analyses in sequence.

Delegated Information Search

The analysis for delegated information search produced significant F ratios for the differences between the two levels of complexity ($F = 33.39$, $p < .001$) and for differences between the levels of failure ($F = 3.00$, $p < .05$). The interaction term ($F = 2.11$) was not significant. The results are shown in graphic form in Figure 1. Post hoc Newman-Keuls tests for differences between failure levels and for identification of failure levels where the obtained differences between complex and simple subjects hold indicated that failure level 4/7 (four out of seven messages communicated failure) produced higher levels of delegated information search ($p < .05$) than failure levels 2/7 and 6/7. Since the significance obtained is marginal, however, and since the curve for simple subjects in Figure 1 does not reflect these differences (yet the interaction term in the ANOVA does not reach significance), this result should probably not be given excessive weight. Newman-Keuls procedures indicate differences between the curves for complex and simple subjects beyond the .01 level for failure levels 1/7, 2/7, 3/7, and 6/7. Differences for failure level 5/7 were also significant ($p < .05$). Again, in the absence of a significant interaction term in the ANOVA we will not place great weight on the absence of a significant difference at failure level 4/7.

According to complexity theory, similar information search characteristics should be obtained for conditions of increasing information load, and conditions of increasing failure. The results for delegated information search obtained under load variation by Streufert, Suedfeld, and Driver (1965) indicated that subjects tended to ask for additional information even when information load was high. However, delegated information search did drop off somewhat under high loads. Complex subjects appeared to be more sensitive to high load, as indicated by a greater decrease in information search requests than produced by simple subjects. The present results show some parallels to those obtained under load variation. Visual inspection

Figure 1:   Effects of Increasing Failure on
            Delegated Information Search
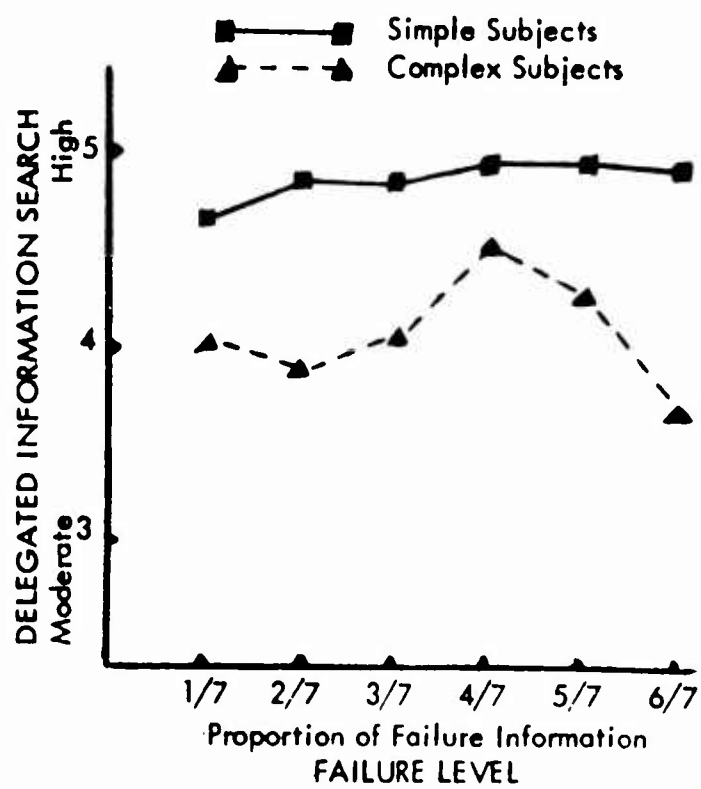
shows that the curves for both experimental treatments are very similar. As suggested by Streufert et al. (1965) for the data obtained in the load condition, the lesser delegated information search by complex subjects could be explained as greater sensitivity of complex subjects to available information, or by the social desirability of information search to which the simple subjects should be more sensitive (cf. Schroder et al., 1967). If social desirability should be a factor, then the differences between complex and simple subjects which are obtained here should disappear or reverse for the analysis of self-initiated information search (see below; cf. Streufert, et al., 1965).

The absence of a significant F ratio for the interaction term and a visual inspection of the curves (Figure 1) obtained here, as compared to those in the load variation (Streufert et al., 1965), suggests that the results of the present experiment may represent a limited segment of the relationships obtained under load variation.[7] In other words, failure levels may "add into" a total environmental complexity effect at a lower rate than the previously used information load levels. We will return to the theoretical implications of this suggestion below.

Self-initiated Information Search

The analysis of variance for self-initiated information search produced a significant F ratio for failure levels (F = 3.66, p < .01). Differences between simple and complex subjects (F = 1.10) and the interaction effect (F < 1.0) were not significant. The results are shown in graphic form in Figure 2. Post hoc Newman-Keuls analyses indicate significant differences between failure level 3/7 and levels 1/7 (p < .01) and 2/7 (p < .05).

Complexity Theory: Search and Failure Levels

These results suggest that self-initiated search initially increases as failure increases, and then tends to level out.[8] These results, obtained under failure variation, are quite divergent from those obtained by Streufert et al. (1965) under the supposedly (cf. Schroder et al., 1967) comparable load variation. Streufert et al. found that increasing information load (environmental complexity) is associated with decreasing search, a relationship that held more strongly for simple than for complex subjects. In the

Figure 2: Effects of Increasing Failure on
Self Initiated Information Search
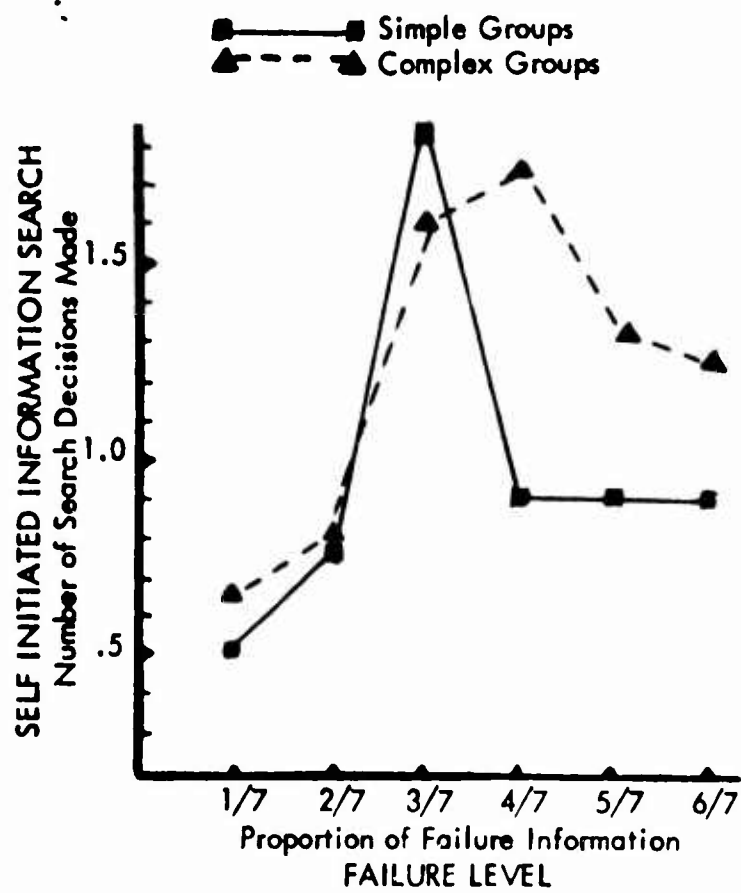
present research, the effect is nearly reversed. At lower levels, increasing
failure (environmental complexity) produces increasing search. Visual inspec-
tion of Figure 2 suggests that search may drop under higher failure levels,
as it did under high load levels; however, this drop is not significant and
must consequently be disregarded. In other words, the data fail to support
the "parallel effects" prediction which complexity theory makes for load con-
ditions and failure levels as joint components of the "environmental complexity"
dimension.

Other Theories: Search and Failure Levels

The potential correspondence of other theories of information search to
the present data may be of some interest. Since these theories are not con-
cerned with other than active search, we have not discussed them with regard
to delegated search. Even with regard to self-initiated search, some problems
remain. Unfortunately, most theories of information search are not suffici-
ently broad to permit testing all of them with the same research methodology,
as, for instance, that used in the present research. However, comparison of
the results obtained here to extrapolations from those theories may at least
suggest whether the theories can be applied to research of this kind.

Brock's (in press) commodity theory suggests that the value of informa-
tion (and with it information search) should be inversely related to infor-
mation availability. Streufert et al.'s (1965) results with information
load variation in the same research setting would support that proposition.
In the present research, however, information load, information relevance,
etc., was held constant. How does Brock's theory relate to failure? Streu-
fert and Castore (1968) have shown that failure has specific effects on sub-
jects' perception of information quality. One might assume that information
value also relates to information quality: the higher the quality of infor-
mation, the less need for search. Streufert and Castore have shown that sub-
jects exposed to increasing failure in this environment perceive information
quality as initially increasing, then remaining at constant levels. Trans-
lating this finding into our extrapolation of Brock's views suggests that
information search should initially (when perceived quality levels are lower)
be higher, then remain constant at somewhat lower levels. The data do not
support such a view.

Lanzetta and associates relate information search to uncertainty and information importance (see above): the greater the uncertainty, and the less extreme the importance, the greater should be the search. If we want to assume that "uncertainty" (in Lanzetta's sense) for the present research setting implies greater knowledge of the probable outcome of the "game," (cf. Streufert and Streufert, 1967), then this certainty should increase in some fashion with increasing failure levels (cf. Streufert and Streufert, 1967; Castore and Streufert, 1966; Higbee and Streufert, 1968). In other words, information search should then show a general decrease. The data do not support such a view.

The second of Lanzetta's propositions is concerned with value: as value increases, information search should decrease. If we can conceive of failure as producing greater levels of value for (hoped for) neutral or favorable information, then the information search curve obtained (at least in the low through intermediate failure levels) would support Lanzetta's views.

A segment of the theory of Feather (1966) is most directly applicable to the present data. Feather predicts that the tendency to choose information X is a function of $T_{x,g} + T_{x,p}$,[9] where $T_{x,g}$ is the positive tendency to select X because it <u>may</u> lead to rewards or goals, and where $T_{x,p}$ is the negative tendency not to select X because it <u>may</u> lead to threats or punishment. In the present research methodology the necessary goal-oriented behavior (cf. Feather, 1966) can be assumed (Schroder et al., 1967). Information search behavior under low failure levels should consequently show primary effects of $T_{x,g}$, and with it rising information search activity. However, as the effects of $T_{x,p}$ begin to be felt under further increasing failure levels (when information obtained communicates failure, or decisions based on obtained information result in failure more often than not), search should level off, and then begin to decline. The data obtained provide reasonable support for such a view.

Complexity Theory: Individual Differences

No differences between simple and complex groups of subjects in self-initiated information search were found.[10] The predictions of complexity theory

(Schroder et al., 1967) that complex subjects or groups of subjects should engage in more search is not supported. At least three interpretations of these results are possible: (1) The absence of differences may be due to the above discussed potentially lesser additive effect of failure. In other words, levels on the environmental complexity continuum where Streufert et al. (1965) obtained higher search for complex subjects as compared to simple subjects may not have been reached. (2) Failure may not have the effects predicted by complexity theory; in other words, the proposition that load, failure and success add into a combined "environmental complexity" dimension may be in error. This interpretation is unlikely, since Streufert (in press) and Streufert and Streufert (in press) have demonstrated that the effect of load and failure levels shows similarities for integrative information processing. However, it may be necessary to limit the meaning of the environmental complexity dimension to correlates of decision making (e.g., integrative information utilization), and exclude perceptual and information search behavior. Further research on these attributes appears needed. (3) Greater information search may not be, as predicted by the view of complexity theory proposed by Schroder et al. (1967), a reliable characteristic of complex subjects, or groups of complex subjects. The results of Tuckman (1964), Karlins (1967), Karlins and Lamm (1967), and Stager (1967), as well as part of the results obtained by Streufert et al. (1965), would argue against such a conclusion. In light of the view and research reported by Streufert et al. (1965), and in light of the fact that differences between simple and complex groups of subjects in this research are obtained for measures of information utilization (see below), we may conclude that the absence of search differences are most likely due to the environmental characteristics, i.e., the employed failure levels. Whether failure has specific effects on the search characteristics of complex subjects, or whether the absence of differences is due to a possible restriction of failure as compared to load on the environmental complexity dimension, as suggested above, remains to be determined by future research.

Information Utilization: Frequency

The Analysis of Variance for information utilization frequency produced significant F ratios for differences in complexity ($F = 7.31$, $p < .05$) and failure levels ($F = 4.31$, $p < .01$). The interaction term ($F = 1.58$) was not significant. The results are shown in graphic form in Figure 3.

The results for failure levels (Newman-Keuls tests indicate differences for failure levels 3/7 and 4/7 as compared to 1/7 and 6/7 ($p < .05$)) support the U-shaped curve proposition of complexity theory.[11] In the absence of an interaction effect, an interpretation of the location of differences between simple and complex subjects on failure levels has to again be made with some caution. Newman-Keuls analysis indicates differences at failure levels 4/7 and 5/7 ($p < .05$). Complex subjects use more information obtained through search in an integrative fashion than simple subjects, particularly at moderately high failure levels. These results tentatively support the conclusion that failure is a lesser additive component than load (as used in previous research).

This conclusion, in combination with the findings of Streufert et al. (1965), does not support the prediction of Schroder et al. (1967) suggesting generally greater information orientation of complex as opposed to simple subjects. Rather, the results tend to support the extension of that theory proposed by Streufert et al. (1965) suggesting that greater information search by complex subjects can be expected only when environmental conditions do not openly further information search, in other words, when the necessity for search is more remote.

Information Utilization: Efficiency

The Analysis of Variance for information utilization efficiency produced significant F ratios for differences in complexity ($F = 11.39$, $p < .01$) and failure levels ($F = 5.30$, $p < .01$). The interaction term is not significant. The data are shown in graphic form in Figure 4. Post hoc Newman-Keuls comparisons show that failure levels 5/7 and 6/7 differ ($p < .01$) from failure levels 2/7, 3/7, and 4/7. In addition, failure level 1/7 differs ($p < .05$) from level 6/7. Differences between complex and simple subjects are obtained for failure level 5/7 ($p < .01$).

Figure 3: Effects of Increasing Failure on the
Frequency of Information Utilization
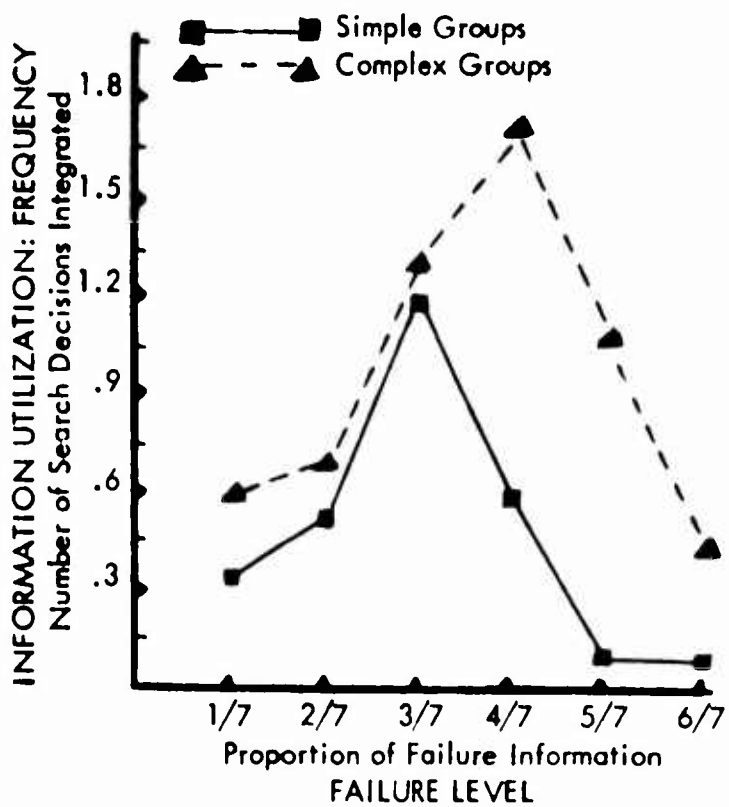
This measure has not been included in previous research. It is added here, since it provides an estimate of information utilization that is independent of information search (assuming that some search occurs). In addition, it may provide an estimate of quality rather than quantity of information utilization. The data show that both complex and simple groups of subjects (no matter how much search they engage in) make integrated use of more than half of the information supposedly obtained through search, until fairly high failure levels are reached. At this point both information search and information utilization drop to lower levels. At failure level 6/7 only about 10% of the information gained through search is used by groups of simple subjects, while groups of complex subjects utilize about 30% of the information.

It should be noted that this measure does not follow the "inverted U-shaped curve" characteristics postulated by complexity theory for integration (and integrative information utilization). Low failure levels do not produce low information utilization efficiency. Nevertheless, complex groups do exceed simple groups on this measure. This result suggests that meaningful differences might exist between quantity of integrated (complex) information processing as shown in Figure 3 (cf. Schroder et al., 1967) and "quality" of integrated information processing. Future revisions of complexity theory should consider such differences.

Conclusions

What implications an be drawn from this research? First, it appears that failure levels adding to a total of six failure messages out of seven informative messages may add less than the information load values (quantity of informative messages per unit time) used in previous research into a total environmental complexity aggregate (as postulated by the complexity theory of Schroder et al., 1967). A more extensive comparison at higher failure levels as part of higher load levels appears useful. However, it should be noted that research of that kind would not be able to test for the lower levels of integrative behavior obtained in previous research employing load variation, unless both information load and failure levels are simultaneously varied. To assure experimental control under these conditions, it may be

Figure 4: Effects of Increasing Failure on the
Efficiency of Information Utilization
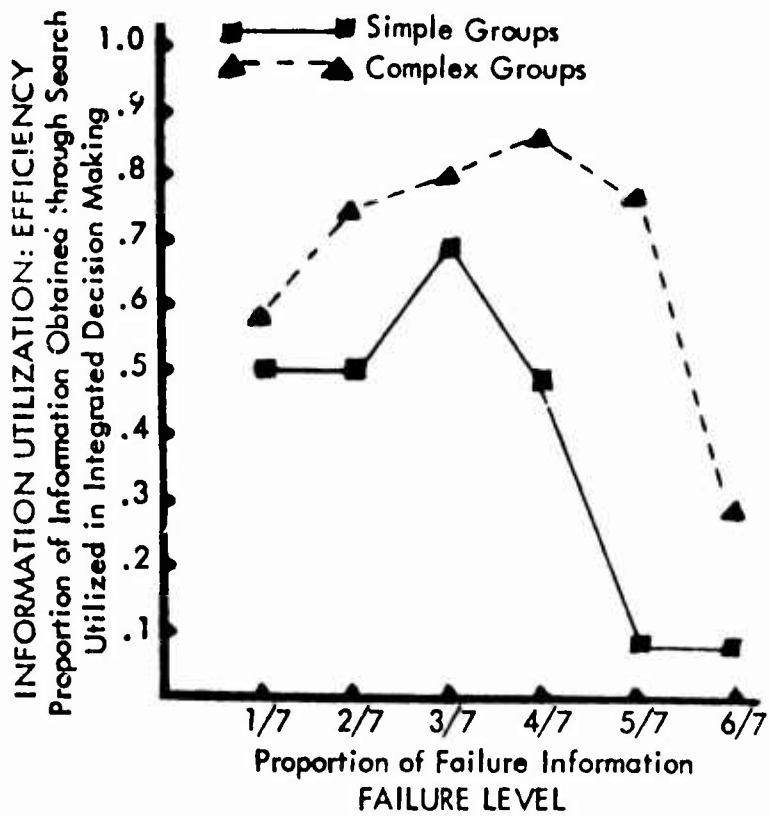
FAILURE LEVEL

useful to initially establish whether the "additive" relationship postulated
by Schroder et al. between load and failure levels is linear or curvilinear.

Second, the results suggest that the propositions of complexity theory
as proposed by Schroder et al. (1967) and Streufert et al. (1965) with regard
to information search seem somewhat oversimplified, if at all applicable.
First, no parallel effects of load (Streufert et al., 1965) and failure (in
the present research) were found. Secondly, information search appears to
be not necessarily greater for persons or groups of complex conceptual struc-
ture. Rather, it may exceed the information search levels of simple persons
or groups only, when conditions (or social desirability) are not particularly
conducive to information search. The results obtained here are, however,
in some agreement with the view suggested by Streufert et al. (1965). In
other words, an extension of complexity theory from "human information pro-
cessing" to "information receiving" and "information producing" character-
istics may require more theoretical care than previously employed. The infor-
mation search theory of Feather (1966) appears to predict some of the results
of this research better than complexity theory. Finally, we may conclude
that the propositions of complexity theory with regard to integrative infor-
mation utilization hold as long as quantity of integrations rather than some
measure of quality is used. The relationship of environmental complexity to
quality measures may require further study.

Footnotes

1. Research support from the Office of Naval Research, Group Psychology Branch, is gratefully acknowledged.

2. It has been repeatedly established that relationships between intelligence and complexity are very low or non-existent. The same holds for data collected in the present experiment.

3. Note that such high levels of load did exist for the novel situations utilized by the research of Tuckman (1964), Karlins (1967), and Karlins and Lamm (1967). The data from the various experiments are consequently in agreement with each other.

4. Detailed descriptions of the game are presented by Streufert, Kliger, Castore and Driver (1967) and Streufert, Castore, and Kliger (1967). The game is a complex experimental simulation permitting experimenter controls (programming for fixed dequence) of the subjects' environment throughout their participation in the game.

5. In addition to its value as an instrument of information, presenting facts about "Shamba" to the subjects on a number of dimensions, the manual was useful to equalize the experience of subjects before beginning experimental participation. Some of the variability due to immediate pre-experimental experiences of subjects was thereby reduced.

6. On first thought, randomization of failure levels might be conceived as an attractive alternative to sequential increase of failure levels. However, as previous research has shown (cf. Streufert, in press), any decrease in failure is perceived by subjects as success. Linearly increasing failure perception as a function of increasing failure levels can be reliably obtained only when sequential failure induction is employed (cf. Castore and Streufert, 1966; Higbee and Streufert, 1968).

7. It should be considered, however, that load variation used 2, 5, 8, 10 (optimal), 12, 15, and 25 independent items of information per one-half hour period, while the present experiment uses failure levels only one step apart for a constant information load of 7. In addition, the "additive" relationship proposed by complexity theory may not necessarily be linear.

8. As demonstrated in past research (cf. Streufert, Streufert, and Castore, in press; Streufert, in press; Streufert and Streufert, in press; and Higbee and Streufert, 1968), the teams in this game do not usually experience a warm-up effect of any size, so that the obtained initial increase in information search is not likely due to such a beginning effect. Nevertheless, we cannot entirely exclude some "influence of learning how to play the game" in the absence of failure level randomization. As demonstrated below, random failure induction cannot be utilized for research of this kind.

9. Although Feather considers choice X, when Y, Z, etc., are available as alternate choices, we will modify his choice constellation to mean: X means choosing to search for information, and the alternative Y means not to search for information.

10. These results suggest that the differences between simple and complex subjects obtained for delegated information search are likely due to the sensitivity of simple subjects to the social desirability of information search. This finding, suggesting the simple subjects exceed complex subjects in search only under the delegated condition, parallels the results reported by Streufert et al. (1965) under load variation.

11. This result is particularly meaningful, since complexity differences for the measure of self-initiated information search (on which this measure is somewhat dependent) were not obtained.

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13. ABSTRACT

The effects of increasing failure and of individual differences in the complexity of conceptual structure on dyad decision-making teams were examined. A complex experimental simulation environment was used as the research method. It was found that simple subjects engaged in more delegated information search than complex subjects, probably due to the influence of social desirability. No differences between simple and complex groups of subjects were found in self-initiated information search. This form of search increased with initial increasing (lower) failure levels, and remained fairly constant under higher failure levels. Two measures of integrative information utilization were employed. The number of information search moves later utilized in integrative (strategic) decision making produced an inverted U-shaped curve with optimal levels under moderate failure conditions. Efficiency of information utilization showed a general decrease as failure increased. Complex groups of subjects exceeded simple groups on both measures of information utilization. The data produced only limited support for complexity theory, and did support, where applicable, the information search theory of Feather.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Information Search						
Information Utilization						
Failure						
Complexity Theory						
Comodity Theory						
Consistency Theory						
Decision Making						
Uncertainty reduction						

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